(6) The skin-friction of even surfaces is practically independent of the material composing them.

(7) The resistance of symmetrical spindles and wedges of easiest shape, as of simple planes gliding at the most efficient angle of flight, is roughly, one-half friction, one-half unbalanced pressure.

HYTHERS AND THE COMPARISON OF CLIMATES.

Under the above title we had the pleasure of publishing in the MONTHLY WEATHER REVIEW in June, 1907, page 267, a letter from Mr. W. F. Tyler of Shanghai that had been a long time delayed. At that time we had not read Mr. Tyler's recent memoir—"The psycho-physic aspect of climate. London, 1907,"[1] but were desirous to make known his exprest hope (MONTHLY WEATHER REVIEW, June, 1907, XXXV, p. 268) that someone would investigate the limiting conditions of temperature and humidity under which animal life can exist. By experimenting upon animals in confinement such a research can be pushed to the determination of the death point. So far as human life is concerned there are many occupations in which life continues under observable extremes of heat and cold, dryness and moisture, calm and winds. Those who will keep records of their sensations when employed in iron or steel works, or in gas works, and especially in the well-regulated furnace rooms of ocean steamships,—those on the other hand who labor in the sunshine and pure air of the Imperial Valley and Salton Sea or the Sahara Desert, and those who as aeronauts or mountaineers penetrate cold clouds, should be able to add considerably to the data that Mr. Tyler is collecting for study.

The Editor recalls vividly his own experience in going from the deck of a steamer down into the furnace room with the stokers; the temperatures then determined by him with the protected sling psychrometer were about as given by (1) and (2) in the table. Another experience in the hot, dry air of a room heated by a Russian furnace gave observations (3) and (4). In the warm dry air of sunny winter quarters in Washington, such readings as (5) and (6) were obtained.

Perhaps the most delightful conditions were those of (7), prevailing thru the night in a strong southeast trade wind on the summit of Telegraph Hill on the Island of Ascension in February, 1890, where we could sleep without protection in a wind whose temperature scarcely varied from those of (7).

TABLE 1.—*Indoor and outdoor humidities observed by Prof. C. Abbe.*

Locality.	Dry bulb.	Wet bulb.	Dew point.	Relative humidity.
	°F.	°F.	°F	*Per cent.*
Atlantic steamer:				
(1) In the free air	91	85	83	78
(2) In the furnace room	120	91	83	33
Russia:				
(3) In the free air	0	2	20	33
(4) Furnace-heated room	120	65	20	1
Washington, D. C.:				
(5) In the free air	33	30	25	70
(6) Warm, sunny room	80	54	26	12
Island of Ascension:				
(7) In the free air	66	65	64	95

Most of these seven different conditions are agreeable to the writer with a proper adjustment of the wind velocity, but the sensations produced are widely various: thus (7) is restful and relaxative; (1) is perfectly indolent; (2), (4), and (6) produce a restless, uneasy, creepy, cold sensation as the skin becomes dry and harsh, one must drink much water and can scarcely do enough muscular exercise to counteract the dryness and keep the skin moist by a rapid circulation of the blood; (3) and (5) stimulate to exhilaration and to excellent intellectual work.

The following conditions—

(8) Free air 55°, wet 50°, DP 45°, RH 73 per cent,

(9) Free air 60°, wet 52°, DP 45°, RH 68 per cent,

are admirable for outdoor exercise and the attendant intellectual stimulus, when the rapid circulation of the blood enables the brain to work rapidly, easily, smoothly, and with precision. One who works steadily for several hours in quiet until his food supply becomes low, the blood fills with effete matter faster than the purifying organs can eliminate it, and the circulation becomes feeble—will usually find himself growing apparently colder, and will require the temperature of the room to be raised from 50° to 60° and perhaps to 70° or 80°, *i. e.*, to temperatures that would have seemed very uncomfortable at the beginning of his work.

These experiences are worthy of record and study, they will on the one hand elucidate the needs of our human physiology and on the other hand help us to more clearly define the relation between natural climates and the evolution of the peculiarities of the races of mankind.

The great variety of climates offered by the stations of our Weather Bureau and the frequent interchanges of observers suggests to us that each make a list of the stations at which he has lived, the length of time in years and months and the impressions produced on him as to the influence of the respective seasons of the local climates.

This information may possible be condensed into tabular form and a few general conclusions be drawn from the experiences of so many men. Mr. Tyler reminds us that for uniformity's sake the influence of the climate should be recorded on a scale of 0 to 10 where 10 will represent the worst day, hot, damp, close, muggy, enervating, that the observer remembers to have experienced at any time; and 0 will represent an ideal summer day, warm, brisk, bright and bracing. In the first case no diminution of clothing makes the free air less uncomfortable and in the second case no increase is needed in order to make it more comfortable. Mr. Tyler recommends that the estimates relate especially to the sensation at the noon or mid-day hours, unless indeed the observer wishes to make a very complete record and determe the diurnal changes.

This is a subject that we earnestly commend to the attention of the experts in physiology and psychology who are considering appropriate researches in several of our best universities.—*C. A.*

THE RELATIVE HUMIDITY OF OUR HOUSES IN WINTER.

In connection with the above note on Hythers and Climates, it may be of interest to many readers to have an account of certain related observations carried out by Prof. R. DeC. Ward in Cambridge, Mass., eight or nine years ago.[1] His account and comments are given in slightly changed form here.

The observations.—The observations were made in the study of the observer by means of H. J. Green's Marvin sling-psychrometer, and extended over three weeks of November, 1899, from the 3d to the 23d. The hours of observation varied, but the number was from two to five daily. Each observation comprised a record of the readings of the wet and dry-bulb thermometers, the condition of the out-of-doors weather, the amount of ventilation by means of the window, the temperature of the air coming from the furnace, and the stage of the water in an evaporating pan placed inside the register of the room.

The study in which the observations were made was heated by hot air from an ordinary hot-air furnace provided with the usual small evaporating pan. Inside the delivering register stood a vessel holding a little more than half a liter of water.

[1] See Monthly Weather Review of May, 1907, p. 227, column 2.

[1] The results were first published in the Boston Medical and Surgical Journal, March 1, 1900; later revised and printed in The Journal of School Geography, I, 1902, pp. 310–317.

This vessel had to be filled about once a day, altho the rapidity of evaporation was found to depend so directly upon the amount of heat from the furnace that the time required to evaporate the water was very variable.

The observations have been summarised in the accompanying Table 1. In this table the values given for the outdoor elements have been taken from the Richard thermograph and hygrograph exposed at the Harvard College Observatory, and are the recorded readings for the hours corresponding to the times of the indoor observations. These means for the outside air are thus not the true means for the day, but they serve the purpose of the comparative observations here presented.

TABLE 1.—*Observations on indoors humidity, during November, 1899, by R. DeC. Ward.*

Date.	Number of observations.	Inside air.		Outside air.	
		Mean temperature.	Mean relative humidity.	Mean temperature.	Mean relative humidity.
		°	*Per cent.*	°	*Per cent.*
3	5	69	28	35	66
4	5	71	39	42	69
5	5	71	30	43	64
6	4	69	29	34	68
7	5	68	32	39	63
8	5	71	31	44	69
9	4	69	32	42	69
10	3	67	32	47	60
11	4	69	33	28	77
12	3	64	30	23	70
13	4	67	24	23	51
14	3	67	26	25	75
15	3	71	31	28	91
16	4	72	29	36	68
17	2	68	27	24	66
18	2	68	31	28	90
19	3	71	40	42	87
20	3	70	28	39	69
21	4	69	25	41	70
22	4	71	30	46	77
23	3	72	26	43	72
Means		69	30	36	71

Notes to the table.—The maximum relative humidity outdoors was recorded on November 4 at 8 a. m. It had rained during the night, the outside air was very damp, and an easterly wind was blowing. The window was partly open and but little heat was coming from the furnace. The outside humidity was 92 per cent and the conditions mentioned were clearly favorable for a high degree of relative humidity indoors. At noon of this day the indoor humidity was still high, 45 per cent, but the weather was then beginning to clear, the wind gradually veering to the northwest. The window was still open.

The lowest relative humidity was 21 per cent, recorded November 23 at 10 a. m. The outside weather was clear, with a moderate northwest wind, and the relative humidity was 68 per cent. The windows were shut and there was a good supply of heat from the furnace.

The maximum relative humidity for a whole day was 40 per cent recorded on November 19, a damp, rainy day, with overcast sky. The window was open thruout the day and there was moderate heat from the furnace. Outdoors the relative humidity averaged 37 per cent which was exceeded on only two other days.

The minimum humidity for a whole day was 24 per cent, recorded on November 13, a clear, cold day, with moderate to brisk northwest wind, and on the outside relative humidity of 51 per cent. The windows were shut most of the day and the temperature of the room averaged 67°. The outdoor humidity was the minimum for any whole day during the period of observation.

The mean relative humidity of the outside air for the whole period was 71 per cent or 40 per cent in excess of the mean for the indoors air.

Discussion.—The relative humidity in a room is clearly the resultant of severable variables, among which are the temperature and humidity outdoors, the amount of heat coming from the furnace, the amount of evaporation from the evaporating pans, the extent to which the room receives the outside air thru the open windows, etc.

It appears from the data that the relation between the relative humidity of the air outside and inside is fairly close, increasing relative humidity outside being closely followed by increasing relative humidity indoors, and vice versa. The weather conditions during the absolute maximum of 45 per cent, and the daily maximum of 40 per cent were, as has been seen, precisely such as would have led one to expect high humidity indoors. These same relations appear distinctly on many of the other days of the observations. Thus on November 4, a change of wind from southeast to northwest, accompanied by clearing weather, was closely followed by a decrease of 34 per cent in the outside relative humidity and of 6 per cent indoors. Again, on November 11, a change of the wind to the east with rain, brought a rise in relative humidity of 15 per cent outside and of 6 per cent indoors. The next day, November 12, was rainy, followed by a clearing day, with northwest wind, and the relative humidity fell steadily from 32 per cent at 8 a. m. to 30 per cent at noon, and to 28 per cent at 6 p. m., the decreasing humidity keeping pace with the decreasing cloudiness and increasing velocity of the dry northwest wind. Outside the relative humidity fell from 78 per cent at the first observation to 69 per cent at the second and 63 per cent at the third. The windows were closed at the time of all the above changes.

Indoors climate vs. *an arid climate.*—The following Table 2, presents the relative humidities at a number of localities and these when compared with the records within the study as just related, suggest some very interesting conclusions. They show clearly that the atmosphere of Professor Ward's study was drier than that of many desert regions, dry to the point of being dangerous to health as he shows. He finds that the strain which is put upon the body in the rapid readjustment required when we go from the high temperatures and desert aridity of our houses in winter, into a temperature 70° to 90° lower and a relative humidity of 70 to 100 per cent is a greater one than we ought to repeat day after day and many times a day.

TABLE 2.—*Low relative humidities in the United States.*

Station.	Mean annual.	Mean monthly minimum.
	Per cent.	*Per cent.*
Yuma, Ariz	42.9	34.7 in June.
Santa Fe, N. Mex	44.8	28.7 in June.
Pueblo, Colo	46.2	37.6 in April.
Death Valley, Cal	23.0 for May to September, 1891.	

In the dry interior of the great Eurasian Continent we find the following relative humidities:

Southwestern Siberia and western Turkestan have a mean of 45 to 50 per cent in July. Yarkand, in eastern Turkestan, has a July mean of 47 per cent. In the arid region about the sea of Aral, Nukus has a June mean of 46 per cent and a 2 p. m. June mean of 19 per cent. Petro-Alexandrovsk, 1.5° west of Nukus, and in the desert, has a June mean of 34 per cent. Kasalinsk, latitude 45.8° north, longitude 61.2° east, has a July mean of 45 per cent. The air is still drier in the deserts near the equator. Ghadames, Tripoli, has 27 per cent in July, and 33 per cent in August. The Kufra Oasis has 27 per cent in August and a 3 p. m. August mean of 17 per cent. In the Punjab and northwestern India, Lahore has 31 per cent and Agra has 36 per cent in May.

It is generally acknowledged that the winter temperatures of our houses are too high, but the excessive dryness of the indoors air and consequent rapid evaporation from the skin combined make most of us uncomfortable unless the temperature is kept up to 70°, or higher. Were the relative humidity of the house air higher, as it always is in the kitchens where steam is continually being sent into the air, then a temperature of 65° would be very comfortable. Such moisture can be introduced into the house air by increasing the evaporating area of the water-pans in the hot-air furnace or by placing similar pans over the super-heated steam coils of the steam-heated house.

Observations somewhat similar to the above were also made by Dr. H. J. Barnes[3] in his own office in Boston, and also in other buildings in Boston. By means of an apparatus of his own devising Doctor Barnes was able to maintain a mean relative humidity of 53 per cent in his own office. This device placed over the delivering register of the hot-air furnace evaporated on the average four and one-half quarts of water daily, and the resulting increased relative humidity kept the office comfortable at a temperature of 65°, while under the usual drier conditions the room must have a temperature of 70° or 71°.

TABLE 3.—*Dr. H. J. Barnes' table of relative humidities in various Boston buildings.*

Place and time.	Heated by—	Mean relative humidity.	
		Indoors.	Outdoors.
		Per cent.	*Per cent.*
City Hospital, 7 days, December, 1878	Indirect steam	29	71
Office of Dr. Barnes, 7 days, January, 1896	Hot-air furnace	27	73
Office of Dr. Ayer, 10 days, February, 1896	Indirect steam	36	70
Women's Hospital, 8 days, February, 1896	Indirect steam	24	71
City Hospital, 12 days, February and March, 1896	Indirect steam	38	74
Means		31	71

SCIENTIFIC BALLOONING AND WEATHER FORECASTS.[1]

By Dr. K. BAMLER, Essen. Translated by Prof. A. G. MCADIE.[2]

One of the chief problems of aerology is the improvement of the forecasts. Every prominent daily paper now publishes a weather bulletin based upon a synoptic weather map. In our country [Germany] the material for this map is collected by the German Hydrographic Office, or Seewarte, in Hamburg, and the forecasts are prepared by some proper central office. The data used by the Seewarte in preparing the weather map are from stations having nearly the same elevations. They give us a picture of the meteorological conditions at the time, as they existed at the bottom of the sea of air. Long experience enables us in many cases to determine what the ensuing weather conditions will be. But so long as we do not know the laws underlying the variations of the individual meteorological factors, so long will forecasting continue an uncertain science; and these laws can never be determined from observations made at the surface of the earth, be they ever so painstaking. We must make observations at greater elevations, but not on high mountains, for such are not wholly free from the influence of the ground. We must rise into the free air and observe there, and this is the province of aerology.

The scientific results of the instrumental observations made in the balloons sent up on the international dates of November, 1907, by the Lower Rhine Society for Aeronautics, show how valuable such ascensions are for forecasting. On November 6 the balloon "Bamler," with Ernst Schroeder of Essen as pilot and Engineer Mensing as observer, ascended from Mülheim and after four and one-half hours landed near Goor, in Holland. On the 7th of November the balloon "Elberfeld," with Professors Silomon and Laubert, ascended from Mülheim and after a trip of four hours landed in Wesel. Both ascensions aimed to reach the greatest possible height and make detailed temperature observations at all levels. Altho both pilots used up all of the 200 kilograms of ballast in their efforts to keep the balloons steadily ascending to a maximum altitude, yet an elevation of only 2,400 meters was attained. This apparently poor record is readily explained by the temperature distribution, as we shall see later.

On November 6, the temperature distribution was as follows: At the start, 10 a. m., a light fog prevailed near the ground and a temperature of 2° C. was recorded, and this gradually decreased up to a height of 600 meters. At this level the balloon was above the layer of haze and the temperature now rose steadily until a height of 1,500 meters was attained.

At the same time the difference between the readings of the dry and wet thermometers increased, indicating that the air became drier with increasing altitude. This is more apparent in the following table:

TABLE 1.—*Humidity observations in the "Bamler," November 6, 1907.*

Altitude of balloon.	t_d	t_w	$t_d - t_w$
Meters.	°C	°C	°C
Ground	2	1	1.0
640	4	1.2	2.8
940	5	2	3.0
1100	6.3	2.3	4.0
1300	8.0	3.	5.0
1450	8.4	1.1	7.3
1500	9.0	....	....
1900	9±	....	4.0
2150	6.8	....	....

At the 1,450 meter level was the driest air noted during the ascension, with a relative humidity of only 14 per cent. The highest temperature, 9° C., was reached at 1,500 meters, and this temperature continued practically up to 2,000 meters, but the relative humidity increased so that at 1,900 meters there was a depression of only 4° C. Above 2,000 meters the temperature fell slowly, and at 2,150 meters read 6.8° C. Values at greater elevations could not be taken, owing to difficulty in controlling the balloon. Practically similar temperatures were found during the descent, except that near the earth's surface, owing to sunshine, the temperature had risen to 5° C.

How, then, are we to explain this unusual distribution of temperature? Unusual because there should be a fall in temperature with elevation averaging 0.5° C. for each 100 meters. The decrease is easily understood, since the air is warmed chiefly by the heat radiated from the ground. On a normal day the lower air will be warmest, and with increasing elevation the temperature will continue to fall. But in this case the reverse condition existed. It happened that on the dates under discussion a wide-spread area of high pressure with weak gradients, prevailed. In such high-pressure areas the upper air sinks slowly, gradually coming under greater pressure and thus warming and drying as it descends. Under such conditions also we expect to find the highest temperature and lowest humidity close to the ground. But the active radiation fostered by these long, clear autumn nights directly opposes such a distribution of temperature, and the chilled lower air layers tend to form a more or less heavy blanket of fog near the ground. Such a temperature inversion as is shown in these observations, namely, 17° C. in 2,000 meters, is a frequent occurrence in the mountain regions during fall and winter. Indeed it is not unusual, in the upper Rhine section, to find a fog layer 200 to 300 meters in thickness and a temperature of 0° C., while from Sulzer Belchen, at an altitude of 1,400 meters, are reported temperatures of 8° C. to 10° C. and a fine, clear view of the distant Alps.

In what way, then, can we utilize these observations in forecasting the weather for the following day? The forecast issued by the Berlin Weather Bureau was: "Along the coast slowly rising temperature with cloudiness and some rain in

[3] See "The arid atmosphere of our houses in winter" in the Trans. Amer. Public Health Assoc., 1898.

[1] Translated from Illust. Aeron. Mitth. 12te Jahrgang, 1908, p. 29-33.

[2] The translator wishes to acknowledge the kind assistance of Mr. Louis Ludholtz and Dr. C. Abbe, jr., in preparing this translation.